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STUDY OF BIOLOGY TEACHING AND THE PROSPECT OF ADAPTATION OF THE BSCS PROGRAM FOR HIGH SCHOOLS IN ISRAEL. FINAL REPORT.

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REPORTED ARE THE ADAPTATION OF THE BIOLOGICAL SCIENCES CURRICULUM STUDY (BSCS) YELLOW VERSION BIOLOGY FOR USE IN ISRAEL AND A DESCRIPTION OF A FEEDBACK AND EVALUATION SYSTEM WHICH IS BEING USED IN COMPARING THE BSCS ADAPTATION TO THE CONVENTIONAL ISRAELIAN BIOLOGY PROGRAM. PART 1 DEALS WITH THE ADAPTATION OF THE BSCS MATERIALS WHICH WAS DONE BY 25 BIOLOGY TEACHERS FROM VARIOUS TYPES OF ISRAELIAN SECONDARY SCHOOLS (ACADEMIC, AGRICULTURE KIBBUTZIM). A TEXTBOOK, LABORATORY MANUAL FOR THE STUDENT, AND A BOOK FOR THE TEACHER WERE PREPARED SIMULTANEOUSLY. THE PRIMARY TEXTBOOK AND LABORATORY CHANGES FOR EACH YELLOW VERSION CHAPTER ARE GIVEN IN THE REPORT. PART 2 DISCUSSES THE TESTING PHASE WHICH IS DIRECTED AT TWO MAJOR OBJECTIVES. THESE ARE (1) TO PRODUCE FEEDBACK INFORMATION OF TEACHING EFFICIENCY, AS MEASURED BY STUDENT ACHIEVEMENT, ON KEY POINTS IN THE TEXT, AND (2) TO PROVIDE EVALUATION DATA IN COMPARING THE BSCS APPROACH TO CONVENTIONAL BIOLOGY INSTRUCTION. BSCS QUARTERLY ACHIEVEMENT TESTS WERE ADAPTED TO PROVIDE FEEDBACK INFORMATION. THE TESTS USED ON A PRE- AND POST-TEST BASIS FOR THE COMPARATIVE ANALYSIS WERE (1) THE TEST ON UNDERSTANDING SCIENCE (TOUS), (2) INVESTIGATOR-CONSTRUCTED ATTITUDE AND BIOLOGICAL INFORMATION TESTS, AND (3) THE "MILTA" GROUP INTELLIGENCE TEST. THE CONTROLLED EXPERIMENT WAS INITIATED DURING THE 1966-67 SCHOOL YEAR. THE RESULTS OF THE ACHIEVEMENT TESTS, INCLUDING ITEM ANALYSES, ARE BEING MADE AVAILABLE TO ALL PARTICIPATING TEACHERS. (DS)

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Final Report

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Study of Biology Teaching and the Prospect of Adaptation of the BSCS Program for High Schools in Israel

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Submitted on behalf of the
Ministry of Education and Culture
The State of Israel

to the
Ministry of Health, Education and Welfare
The United States

by

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U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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From preliminary discussions it emerged that the current program and the BSCS Yellow Version cover similar material and have a similar, evolutionary, approach. However, the organisation of the material and the emphases are completely different. While the current program emphasizes to a very large extent the structural aspects and descriptive approach, the BSCS program emphasizes mainly the f nctional aspects and the general biological principles. Moreover, in the laboratory work of the BSCS program the quantitative measurements are stressed to a much larger extent than in the current program where mainly qualitative observations are made.

On the basis of these similarities and dissimilarities it was decided to try and run a controlled experiment: To compare the achievements of students studying according to the ordinary program and the BSCS Yellow Version. For this purpose the adaptation of the Yellow Version to Israeli conditions was necessary. Also, a feedback and testing system had to be devised.

A working group of 25 biology teachers from the various types of secondary schools (academic, agricultural, and from Kibbutzim) was assembled. During the two years of the project this group met regularly every three weeks for a day's work. During all vacations longer periods were devoted to common work and study. Every summer vacation a two-week course was run.

The group's work was comprised of the following: Comparison of the BSCS program with the current biology program; Discussion of all the chapters of the chosen BSCS version as to their adaptation for use in Israel; Suggestions for changes and improvements; Discussions of the laboratory experiments and suggestion of additional or alternative experiments; Preparation and revision of tests.

A special emphasis was made on supporting and bringing up to date the teachers' knowledge in the various fields of Biology.

During the adaptation work the various chapters of the Yellow Version were discussed. The subject matter was studied. Its adaptation to the Israeli mentality was evaluated and the didactic approaches discussed. A scientist, expert in the particular field discussed, always participated in the discussions. After the various changes were suggested and agreed upon, the English text was submitted for translation and during translation all the suggested

changes were introduced. The translated text was again revised by the members of the group and scientists, and printed in an experimental edition.

A textbook and laboratory manual for the student, and a book for the teacher were prepared simultaneously.

The adaptation of the book

Numerous adaptations were made in the text and some of the laboratory experiments were replaced. Some major changes were also introduced; Mainly the changes were as follows:

Chapter 1

The introduction into the Chapter was made through the ecological observations and scenery changes every layman may notice in his everyday life.

Malaria was maintained as an example for illustrating how a biological problem is being solved. However, the story of the discovery of the plasmodium and its life history was adjusted to the way this is described by Manson - Bahr. The severity of the problem of malaria in the early days of the Jewish settlement in Israel was introduced together with a curve showing the decline of the malaria cases in Israel from the early fourties (12,500) to the late fifties (71) per year. Two special "Invitations to Inquiry" on the subject of eradication of malaria in Israel were constructed.

Chapter 2

Only few changes were introduced into this chapter. The spontaneous generation and the Entelechy of Aristotle were introduced in a way more similar to the original. The same applies to Leuvenhoek's discovery of the microorganisms.

Chapter 3

How primitive man utilises for his wellbeing the plants and animals in his surroundings was illustrated mainly by the way of life of the Beduin in the Middle Eastern desert as well as by examples of life of primitive men in other parts of the world. Under "scientific Societies and Publication" a paragraph was introduced describing the scientific societies in Israel and the means of communication between scientists.

Chapter 4

Only very slight changes in style were introduced.

Chapter 5

Ionization of NaCl is represented graphically. pH scale is represented in a different way. No major changes.

Chapter 6

Enzyme properties were dealt with in more detail, especially the concept of coenzyme was stressed. NAD and NADP were substituted for DPN and TPN, and their function connected with the concept of the coenzyme previously stressed. In the respiration equation $6H_2O$ were added on the left side and $12H_2O$ resulted on the right side.

Chapter 7

Only minor changes in style were introduced. A photograph of mitosis on Trillia was added as well as a table showing number of chromosomes of some plants and animals.

Chapter 8

The original form of the chapter was preserved. The paragraph "Life in the past" was replaced by one about the life in the past and fossils of Israel.

Photographs of animals and plants through the whole part of Unity were replaced by local ones.

In the laboratory guide for the first 8 chapters very little changes were introduced: An experiment in pH measurement and identification reactions for carbohydrates proteins and fats were added.

As regarding "Diversity", it was felt that introduction to the theory of classification should not be delayed till the discussion of the animal kingdom. A new introductory chapter was therefore written as an opening to the whole "Diversity" part. The title of this chapter is "The diversity among living organisms". It introduces the concepts of "homology" and "analogy" with examples

from plants and animals; The role of homology in grouping the various organisms in "natural groups"; The concept of the "natural group" is stressed and the possible causes of segregation of such groups into subgroups are mentioned. As a result chapter 20 was omitted later on. This new chapter is chapter 9.

Chapter 10 corresponds to the original chapter 9.

The general form of the chapter was conserved, except for a few concepts that were brought up to date. For instance, viruses have enzymes of their own!

Chapter 11 corresponds to the original chapter 10.

The chapter opens with a citation from Leeuwenhoek telling about his amazement and excitement when he discovered the micro-organisms. Then the history of the name "Bacteria" is explained. After that the chapter maintains its original form.

Chapter 12 corresponds to the original chapter 11.

In the part "Control of disease" the order was changed: After "Host resistance and immunization" the use of antiseptics was dealt with. Koch's discovery of Vibric cholerae and the story of introduction of use of antiseptics by Dr. Semmelweis is told. Then synthetic drugs are dealt with and finally antibiotics. Here the discovery of penicillin is told in Fleming's own words. Then the work of Flory and Chain and the work of Waksman are dealt with. Next comes fermentation, then food spoilage. In the end an evaluation is made on the benefits and harms caused by bacteria and the role of bacteria in industrial processes is discussed.

Chapter 13 (original chapter 12)

The chapter begins with Woronin's discovery of Plasmodiophora brassical. From there it goes into the life cycle of mixomycetes. Then the chapter proceeds as the original except that mycorhiza and symbiosis are introduced.

Chapter 14 (original 13)

The chapter itself is almost unchanged in its approach except few additions. The original figure 13-1 was replaced by a figure emphasizing in which geological era the various plant groups reached

their maximum distribution. Also as the Ulva has no complete life cycle on the Mediterranean shores of Israel it was replaced, as an example, by Padina. The part "Algae and the World to-day" was completely rewritten. The role of algae in space travel was described more realistically and not so optimistically.

Chapter 15 (original 14)

The chapter was rewritten to a large extent. The doubtful theories on the evolution of the leaf were omitted. The whole problem of the development of the form of the higher plants was left more doubtful. However, the whole life cycle of the plant was dealt with.

Chapter 16 (original 15)

The problem of photosynthesis was dealt with without mentioning two light reactions; therefore the second light reaction was also omitted from the original fig. 15-9. The spectrum of chlorophyll was shown as spectra of chlorophyll α and β. The structure of the chloroplast and the grana was replaced by a more realistic picture.

Stomata and the water balance of the plant was completely rewritten and brought to the end of the chapter. The role of stomatas as controlling CO_2 absorption and transpiration was stressed.

Chapter 17 (original 16)

The structure of endodermis was explained. Water absorption by the root from the soil was explained in more detail. An illustration showing measurement of root pressure was added. The original fig. 16-11 was omitted as there were doubts as to the validity of its theoretical soundness.

Chapters 18 & 19 (original 17)

It was felt that during the last years so much knowleige has accumulated on the role of hormonal regulation in plants that it warrants a full chapter by itself. Chapter 17 was therefore divided into two: one dealing with the reproduction of the flowering plants, the other - a new one - dealing with development. This new chapter emphasizes the hormonal regulation. Auxins, gibberellin and phytokinins are discussed. Photoperiodism and the role of phytochrome are mentioned. Germination regulating mechanisms are

dealt with.

In the end of this part on diversity an illustrated catalogue of the various plant groups is added.

Not many innovations were introduced in the laboratory guide up to this section. An experiment showing the liberation of oxigen in photosynthesis and several experiments on germination and growth were introduced. In the experiments on auxins curvative tests were replaced by straight growth. Experiments on apical dominance and on effect of gibberellin were also added.

In the part of "Diversity" dealing with animals, only 5 chapters have been prepared and they are now going through the last inspections.

Chapter 20 is introductory and corresponds to the original chapter 18. Chapter 21 (original 19) deals with the paramecium as an example of an animal way of life. The original chapter 20 was omitted as already stated in explanation to chapter 9. Instead an illustrated catalogue of the animal groups is added in the end of this part. Chapters 22, 23 and 24 correspond to the original 21, 22 and 23. Not very many changes were introduced although a few additional illustrations will be added. It was also felt desirable to add a new chapter dealing with function of sense organs and perception of stimuli. It is hoped that an experimental version of such a chapter will be written shortly.

The experiment

During the years 1965-66 a dummy run of the first part of the material was made in seventeen 9th grade classes. In the year 1966-67 the second part of the material is being tested in the same classes. The controlled experiment, covering twenty-six 9th grade classes and half that number of control groups has been initiated at the beginning of the 1966-67 school-year. Continuous supervision of the teachers, regular meetings with them and precise recording of their work, together with the various tests, serve as feedback material. Two supervisors, Mr. Hadomi and Mr. Feuchtwanger, have regular meetings with the teachers before the beginning of every new Chapter. They also visit in classes and laboratories, help with on the spot problems and collect impressions.

Feedback and Testing

Feedback material is collected, in addition to the personal impressions, and recordings of the supervisors, on special forms. Every teacher, when ending a chapter, fills up the forms. He is also encouraged to keep personal records. The forms and records are analysed and discussed in common meetings of the working group. Conclusions are being drawn for revision of the books. Preliminary analyses were made after the first year dummy run of the material. More basic analyses are being embarked on now, during the first year of the experiment proper.

The Testing and evaluation of the project is being conducted by Dr. Jungwirth as outlined in the following:

I. Objectives of the Testing Program

1. To serve as part of the feedback system, i.e. to produce information as regards teaching-efficiency (as measured by student achievement) on key-points of the text.

2. To serve as evaluation of the BSCS method as such, as well as contrasted with orthodox methods of biology-teaching.

II. Testing and Evaluation Instruments

1. Feedback information

The original Yellow Version text is accompanied by four "quarterly" tests, each covering about 10 chapters, and comprising 45 items each.

According to the BSCS policy statement on the use of BSCS tests abroad, dated 17th September, 1964, permission was granted to make use of the original tests, provided that those tests undergo a parallel adaptation to that of the texts. In view of this policy statement it was decided to utilise the BSCS tests, properly adapted, but -

a. to prepare achievement-tests covering approximately 6-7 chapters only, in order to achieve a wider selection of curricular materials,

b. not to exceed 30-35 items per test, in order that no more than a single class-period be taken up per test,

c. to include original (locally constructed) items, wherever the emphases of the BSCS items conflict with local judgement, or where local adaptations require new items, or, in certain cases, adapted BSCS items.

2. Evaluation Instruments

General - It was decided to evaluate the outcomes of the project on two main levels:

a. Information level - For this purpose a biological-information test was constructed, consisting of two parts:

aa. Biological information acquired prior to entry of students to secondary school, i.e. based on the present curriculum of grades 6 - 8.

ab. Information selected from the present curriculum of grades 9 - 10.

Both parts consist of items representing the following subject-matter areas:

Nutrition (human, animal and plant)
Reproduction (human, animal and plant)
Respiration (human, animal and plant)
Photosynthesis and energy cycles
Taxonomy

b. Non-informative level

ba. The "Test on Understanding Science" (TOUS)

The original BSCS Project (USA) used a special test (Impact Test) to evaluate this aspect of BSCS-Biology. It was felt, however, that the Impact Test was excessively "subject-matter loaded", and it was decided, therefore, to use a test which would be more "subject-matter neutral". The TOUS (constructed at Harvard University by Cooley and Klopfer) was thought to be a suitable instrument. Permission was obtained from the authors (the copy-right holders) to translate and/or adapt TOUS.

TOUS tests for understanding in the following three sub-areas:

The scientific enterprise
The scientist
Aims and methods of science

bb. Attitude to "Nature" (plants and animals) and to rural life

A preference-test in these two areas, constructed and validated by this investigator in previous research-projects, was selected as a suitable intrument.

c. Intelligence Test

In order to be able to correlate the results of the various testing-instruments, all participating students are tested by means of the "MILTA" group intelligence-test, constructed and validated at the School of Education of the Hebrew University.

All the above mentioned tests are to be used both as pre-tests and post-tests, the pupils' progress to be measured according to the averages of individual advances.

III. Preparation and try-out of the testing instruments

1. School-year 1964-65

a. Construction of information-test
b. Translation of TOUS

These two tests were given a trial-run based on a limited 9th grade population. Item analyses based on the results of this trial-run produced a second edition of both tests, to be used during the dummy-run of the BSCS text beginning the following school-year.

2. School-year 1965-66

The following tests were given as pre-tests:

a. Information test (second edition)
b. TOUS (second edition)
c. Attitude test

Two achievement-tests were constructed:

a. Test I (chapters 1 - 6)
b. Test II (chapters 7 - 12)

Statistical analyses of all five tests were prepared. In view of the results of these analyses, which included

a. reliability-coefficients
b. discrimination indices
c. difficulty indices
d. validity coefficients

certain changes were introduced in all, except the information test.

3. School-year 1966-67

The following tests were given as pre-tests:

a. Information-test (second edition)
b. TOUS (third edition)
c. Attitude test

The following achievement tests were given, or are scheduled to be given:

a. Tests I and II (second edition)
b. Test III (first edition)
c. Tests IV and V (in preparation)
d. Final examination (see below)

IV. The Final Examination

Discussions regarding the aspects and scope of this examination, as well as the desirable testing-approaches are still in progress. It is proposed to give a trial-version of this examination at the end of the dummy-run.

V. Analyses of results

1. Feedback

Results of the achievement tests (including item-analyses) are made available to all participating teachers.

2. Evaluation

The following statistical treatments are envisaged:

a. correlation between I.Q. and TOUS
b. correlation between I.Q. and Information Test
c. correlation between I.Q. and achievement
d. correlation between I.Q. and attitude
e. correlation between attitude and achievement
f. correlation between attitude and TOUS
g. difference of means (and its significance) of achievement between experimental and control groups relating to averages of individual progress as measured by: TOUS, Information-Test and Attitude-Test.

Ways and means of estimating the teacher-effect on pupils' achievement and/or attitudes are under discussion.